Module 9: Reproduction and Genetics

Driving Question: How can we as science journalists help consumers make informed decisions about what they eat and the choices they make?

Note: These Google Documents work best in the Google Chrome browser. If you use another internet browser, formatting may be a problem!

Storyline:

This module is centered on the driving question, “How can we as science journalists help consumers make informed decisions about what they eat and the choices they make?” In order to answer this question, students will consider the different ways that organisms reproduce, and how traits are inherited. They will explore how genetic instructions are used to make proteins, and how changes to these instructions can impact proteins and therefore traits. They will figure out that an organism’s traits are ultimately a product of both their genes and their environment. Students will then research an example of gene technology. The culminating performance task requires students to synthesize this information and create a science journalism piece that will help the public make an informed decision about the consumption of a gene technology product.

In Concept 1: Inheritance of Traits, students are introduced to the Driving Question by viewing a video of a typical grocery store, and the variety of choices that a consumer must make while shopping. Students use this as a module-level phenomenon in order to consider what information they might need to know in order to inform consumers as they make choices. They read about different organisms and how they reproduce either asexually or sexually. Students view yeast budding under the microscope. They use pennies and bingo chips in order to model probabilities in sexual reproduction. They use the information they obtain to create models that compare and contrast asexual and sexual reproduction. Phenomena that drive this Concept include a video of bacteria reproducing, and pictures of family members that look similar yet different. At the beginning of this Concept, students must design an experiment to test how environmental factors affect the growth of Fast Plants. They will collect data throughout the Module that will be used in Concept 3.

In Concept 2: Mutations, students consider the phenomenon of a data set of percent composition of an organism. They make an origami protein, and consider how this process served as a model for how proteins are made in an organism. Students obtain information about the general process of protein creation, and make the connection that genes create observable traits because they create proteins. They use cystic fibrosis as a case study of what happens when mutations occur in genes.
In Concept 3: Factors Affecting the Growth of Organisms, students consider the phenomenon of adult identical twins that no longer look identical. Throughout the module, they collected plant growth data. In this Concept, they will analyze the data and draw conclusions concerning how the plants were affected by various environmental conditions. Students explore the concept of epigenetics as a way to understand that organism traits are affected by both genetics and the environment.

In Concept 4: Artificial Selection, students consider the phenomenon of the variety of Brassica oleracea vegetables. They are introduced to DNA technology by performing a DNA extraction of their own cheek cells. Students then consider the applications of DNA and gene technology. They explore how to distinguish between high and low quality science information sources, and then use this information in order to conduct their own research on a particular gene technology. Students then share this information so that they all have a broad knowledge of several types of gene technology including gene therapy, GMOs, and selective breeding.

For the Performance Task, students will utilize information gained from all four concepts in order to answer the original driving question, “How can we as science journalists help consumers make informed decisions about what they eat and the choices they make?” Students learn about what makes high quality science journalism, and then expand on the research they did in Concept 4 in order to create their own high quality journalism that will inform consumers about a particular type of product they might use. Students give and receive feedback on their journalism pieces, and revise their project based on this feedback.
The Next Generation Science Standards also have assessment boundaries and clarification statements that can be accessed for more explanations about each performance expectation. NGSS Evidence Statements provide educators with additional detail on what students should know and be able to do. These are statements of observable and measureable components that, if met, will satisfy NGSS performance expectations.

**Module Standards:**

<table>
<thead>
<tr>
<th>NGSS PE</th>
<th>DCIs</th>
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| **NGSS MS-LS3-1** Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism. | **LS1.B: Growth and Development of Organisms**  
- Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5)  
- Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. (secondary to MS-LS3-2) | 6-8-LS1.B.2 Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. [Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] |
| **NGSS MS-LS3-2** Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation. | **LS3.A: Inheritance of Traits**  
- Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. (MS-LS3-1)  
- Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. (MS-LS3-2) | |
| **NGSS MS-LS4-5** Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. | **LS3.B: Variation of Traits**  
- In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. (MS-LS3-2) | 6-8-LS4.B.2 Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. [Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, and farming practices).] |
| **NGSS MS-LS1-5** Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. | | |
|   |   | In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism. (MS-LS3-1)  
LS4.B: Natural Selection  
   | In *artificial* selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring. (MS-LS4-5) |   |
Approximate Timeline: 8 weeks (39 sessions)
Big Idea Chart: ([CLICK HERE FOR RESOURCES])
8 weeks total

<table>
<thead>
<tr>
<th>Big Idea:</th>
<th>Concept 1: Inheritance of Traits</th>
<th>Concept 2: Mutations</th>
<th>Concept 3: Factors Affecting Growth of Organisms</th>
<th>Concept 4: Artificial Selection</th>
<th>Performance Task</th>
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<tbody>
<tr>
<td>Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. During asexual reproduction, there is only one parent transferring genetic material to the offspring. Offspring chromosomes are identical to parent chromosomes. During sexual reproduction, two parents contribute genetic material to the offspring. Offspring inherit half of their genes from each parent. The combination of genetic material from two parents allows for genetic variation that makes offspring chromosomes distinct from those of either parent. Models can be used to identify cause-and-effect relationships to predict that more genetic variation occurs in organisms that reproduce sexually compared to organisms that reproduce asexually.</td>
<td>The genetic instructions for forming an organism’s characteristics are located in chromosomes. Each chromosome pair contains two variants of each of many genes. Each gene controls the creation of a specific protein. The protein it creates affects the trait of an individual. Changes, or mutations, to genes lead to changes in the proteins they create, when then affects the structure and function of the organism. Changes in proteins cause changes in traits. Mutations are rare. Some mutations are beneficial, some harmful, and some neutral to the organism. We can create models to describe how mutations may affect organisms.</td>
<td>The growth of an organism is controlled by genetic factors, as well as environmental conditions. Examples of environmental factors include food availability and intake, interactions with other organisms, light availability, space availability, and water availability. As environmental factors may change, growth of the organism may change. Growth is influenced by multiple environmental factors. Because both genetics and environment influence an organism at the same time, growth is the result of both of these things working together. Because both genes and environment influence growth, we can speak about the causes of growth in terms of probability.</td>
<td>Humans influence the inheritance of desired traits in organisms through the process of artificial selection. In artificial selection, humans choose the desired parental traits (determined by genes) which are then passed onto offspring. Examples of artificial selection include gene therapy, genetic modification, and selective breeding. We can research to gather and synthesize information about this. We can use this information to describe how scientists and engineers understand cause and effect relationships in how traits occur in order to design technology solutions to global problems.</td>
<td>Students will work collaboratively to create a science journal issue based on the topic of artificial selection. Students will create submissions such as infographics, articles, data blitzen, etc. to inform the public about a technology that has changed the way humans have influenced the inheritance of desired traits in organisms. Students will evaluate each other’s journals as consumers of science information, examining the credibility, accuracy and bias for the publication.</td>
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<p>| # Ses: | 11 | 9 | 6 (plus 1 session of set up included in Concept 1; plus monitoring) | 8 | 5 |</p>
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<td>Target Questions for each cycle</td>
<td>How are characteristics of one generation passed to the next?</td>
<td>How do genes influence what an organism looks like, how it functions, and how it behaves?</td>
<td>How do organisms grow and develop?</td>
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<td>How can individuals of the same species and even siblings have similar yet different characteristics?</td>
<td>What factors affect the growth of organisms?</td>
<td>How has technology been used by humans to influence the inheritance of desired traits in organisms?</td>
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